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WRENCHING TONG

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WRENCHING TONG

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of co-pending International Publication No. WO 01/38688 A1 having an international filing date of November 17, 2000, and published in English on May 31, 2001 in accordance with Patent Cooperation Treaty Convention Article 21(2). The referenced International Publication is herein incorporated by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention generally relates to a wrenching tong and other power tongs. Particularly, the present invention relates to a wrenching tong for use in making or breaking tubular connections. More particularly still, the present invention relates to a tong which has been adapted to reduce the likelihood that it will damage pipe connections.

Description of the Related Art

[0003] In the construction of oil or gas wells it is usually necessary to construct long drill pipes. Due to the length of these pipes, sections or stands of pipe are progressively added to the pipe as it is lowered into the well from a drilling platform. In particular, when it is desired to add a section or stand of pipe the string is usually restrained from falling into the well by applying the slips of a spider located in the floor of the drilling platform. The new section or stand of pipe is then moved from a rack to the well center above the spider. The threaded pin of the section or stand of pipe to be connected is then located over the threaded box of the pipe in the well and the connection is made up by rotation therebetween. An elevator is connected to the top of the new section or stand and the whole pipe string lifted slightly to enable the slips of the spider to be released. The whole pipe string is then lowered until the top of the section is adjacent the spider whereupon the slips of the spider are re-applied, the elevator disconnected and the process repeated.

[0004] It is common practice to use a power tong to torque the connection up to a predetermined torque in order to make this connection. The power tong is located

on the platform, either on rails, or hung from a derrick on a chain. In order to make up or break out a threaded connection, a two tong arrangement is necessary. An active (or wrenching) tong supplies torque to the section of pipe above the threaded connection, while a passive (or back up) tong supplies a reaction torque below the threaded connection. The back up tong clamps the pipe below the threaded connection, and prevents it from rotating. This clamping can be performed mechanically, hydraulically or pneumatically. The wrenching tong clamps the upper part of the connection and is driven so that it supplies torque for a limited angle.

[0005] This power tong arrangement is also used to torque up connections between other tubulars, for example casing and tubing.

[0006] Normally, in order to supply high torque, the wrenching tong is driven hydraulically. One or two hydraulic cylinders drive the tong through a small angle, typically in the region of 25°, depending on the tong design. Due to the geometric configuration normally used, the torque output of the tong changes as a sine function of the angle driven, which results in a reduction of torque output across the drive angle of up to 15%.

[0007] In order to make up or break out a connection of modem drill pipe or casing, high torque must be supplied over a large angle. This angle is sometimes six times higher than a conventional wrenching tong can supply. In order to overcome this, the wrenching tong must grip and wrench the tubular several times to tighten or break the threaded connection fully. This has a number of disadvantages. The action of gripping and releasing the pipe repeatedly can damage the pipe surface. Due to the high costs associated with the construction of oil and gas wells, time is critical, and the repeated clamping and unclamping of the wrenching tong greatly increases the time taken to attach each new section or stand of tubulars. It also has the effect that the torque provided is discontinuous, increasing the difficulty of accurately controlling the torque with respect to the angle turned.

[0008] Further, the drill pipe may be damaged if the torque applied is above the predetermined torque for making or breaking the connection. Generally, drill pipe connections are designed to makeup or breakup at a predetermined torque. Thus, if too much torque is applied, the connection may be damaged. Conversely, if insufficient torque applied, then the drill pipes may not be properly connected.

[0009] Therefore, there is a need for an improved apparatus for making or breaking a tubular connection. Further, there is a need for an apparatus that will makeup or breakup a tubular connection with minimal gripping and releasing action. Further still, there is a need for an apparatus for monitoring and controlling the torque applied to making or breaking a tubular connection.

SUMMARY OF THE INVENTION

[0010] According to a first aspect of the present invention there is provided apparatus for applying torque to a first tubular relative to a second tubular, the apparatus comprising a first tong for gripping the first tubular and a second tong for gripping the second tubular, wherein the first tong is provided with teeth around a peripheral surface thereof, the second tong is provided with at least one pinion, and the pinion meshes with the teeth in such a way that the first tong and the second tong can be rotated relative to one another when the pinion is rotated.

[0011] Preferably the first tong is a back-up tong and the second tong is a wrenching tong. Both tongs are preferably substantially cylindrical, and an axial passage is preferably provided therethrough for receiving tubular-s. A passage is preferably provided from a peripheral edge to the axial passage of each tong to allow the introduction of tubulars into the axial passage. The pinion is preferably located at or near the periphery of the second tong. A motor may be provided on the second tong and coupled to the or each pinion.

[0012] The second tong is preferably provided with two pinions, although in another embodiment it may be provided with only one. The pinions are preferably located at or near the periphery of the second tong spaced by substantially 180° about the longitudinal axis of the tong. In another embodiment they may be spaced by substantially 120° about the longitudinal axis of the tong.

[0013] Preferably, the first tong comprises a plurality of hydraulically driven clamping jaws for gripping the first tubular and the second tong comprises a plurality of hydraulically driven clamping jaws for gripping the second tubular. Each jaw may be equipped with two or more dies, and is preferably attached to hydraulic driving means via a spherical bearing, although the jaw may be an integral part of the hydraulic driving means.

[0014] Bearings supported on resilient means are preferably provided between the first tong and the second tong to facilitate relative axial movement of the first and second tongs.

[0015] According to a second aspect of the present invention there is provided apparatus for applying torque to a first tubular relative to a second tubular, the apparatus comprising a gear and at least one pinion, and first clamping means for clamping the first tubular within the gear, the pinion being attached to second clamping means for clamping the second tubular, and the pinion meshing with the gear in such a way that the first clamping means and the second clamping means can be rotated relative to one another by rotating the pinion.

[0016] The first clamping means preferably comprise jaws mounted within the gear about an axial passage extending through the gear. The second clamping means preferably comprises jaws mounted within a clamping housing about an axial passage extending therethrough. A motor is preferably fixed to the clamping housing and coupled to the or each pinion.

[0017] According to a third aspect of the present invention there is provided a method of applying torque to a first tubular relative to a second tubular, the method comprising: clamping the first tubular in a first tong; clamping the second tubular in a second tong; and rotating a pinion connected to the second tong and which meshes with teeth provided around a peripheral surface of the first tong so as to rotate the first tong relative to the second tong.

[0018] According to a fourth aspect of the present invention there is provided a method of coupling a tool to a length of tubular, the method comprising the steps of:

securing the tool in a basket;

lowering a tong arrangement having a rotary part and a stationary part, relative to the basket to engage respective locking members of the tong arrangement and the basket, thereby fixing the basket and the tool relative to the stationary part of the tong arrangement; and

rotating the length of tubular using the rotary part of the tong arrangement so as to couple the tool to the length of tubular.

[0019] This method may be used to couple a tool such as a drill bit, to a length of drill pipe. The coupling portion of the length of drill pipe may be brought into

proximity with a corresponding coupling portion of the tool either before or after the lowering of the tong arrangement.

[0020] The length of drill string may be gripped by the rotary part of the tong arrangement either before or after the lowering of the tong arrangement. The length of drill string may be located proximate to the basket containing the tool either before or after the string is gripped by the rotary part of the tong arrangement.

[0021] By carrying out the steps of the above fourth aspect of the present invention in reverse (including rotating the length of tubing in the opposite direction), a tool may be decoupled from a length of tubular.

[0022] According to a fifth aspect of the present invention there is provided apparatus for enabling a tool to be secured to a length of drill pipe, the apparatus comprising:

a basket arranged to securely retain the tool;

a tong arrangement having a rotary portion and a stationary portion, the rotary portion being arranged in use to grip and rotate the length of tubular; and

first locking means provided on the basket and second locking means provided on the stationary portion of the tong arrangement, the first and second locking means being engageable with one another to fix the basket relative to the stationary portion of the tong arrangement.

[0023] Preferably the first and second locking means are engageable and disengageble by means of linear movement of the tong arrangement relative to the basket.

[0024] Preferably, the basket is arranged to prevent rotation of the tool in the basket, wherein in use the rotary portion of the tong arrangement may be used to rotate the length of drill pipe to secure a screw connection between the length of drill pipe and the tool.

[0025] Preferably, one of the first and second locking means comprises one or more slots, and the other of the first and second locking means comprises one or more projecting members, the slots and the members being engageable and disengageable by relative linear movement of the tong arrangement and the basket.

[0026] According to a sixth aspect of the present invention there is provided a tong for use in clamping a length of tubular during the making up or breaking out of a connection, the tong comprising:

a body portion having a central opening therein for receiving a length of tubular; and

at least two clamping mechanisms mounted in said body, the clamping mechanisms being radially spaced about said opening;

a plurality of elongate mounting members disposed between each of the clamping mechanisms and the body of the tong, each mounting member having a flat face for abutting a side of a clamping mechanism and a rounded side for locating in a complimentary shaped recess in the tong body,

wherein each tong may be displaced to some extent from radial alignment with the central opening of the tong.

[0027] The present invention provides a positioning apparatus for determining the position of a tubular with respect to the tong. The positioning apparatus includes a plunger having an end contactable with the tubular disposed on a base. The plunger may be coupled to a visual indicator to indicate the axial travel of the plunger relative to the base.

[0028] In another aspect, the present invention provides a torque measuring flange for determining the torque applied by a motor to the tong. The flange includes a top plate and a bottom plate. The flange further includes one or more wedges disposed about the periphery of the flange. Preferably, two wedges are attached to the top plate and two wedges are attached to the bottom plate. One or more cylinders may be disposed between two wedges, whereby compressing the two wedges causes a piston in the cylinder to compress.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] So that the manner in which the above recited features and advantages of the present invention are attained and can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to the embodiments thereof which are illustrated in the appended drawings.

[0030] It is to be noted, however, that the appended drawings illustrate only typical embodiments of this invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

[0031] Some preferred embodiments of the invention will now be described by way of example only and with reference to the accompanying drawings, in which:

[0032] Figure 1 is a view of an arrangement of a wrenching tong and a back-up tong;

[0033] Figure 2 is a side view of the wrenching tong and back-up tong of Figure 1;

[0034] Figure 3 is a view of the back-up tong of Figure 1;

[0035] Figure 4 is a cutaway view of the back-up tong of Figure 1;

[0036] Figure 5 is a cutaway view of the wrenching tong of Figure 1;

[0037] Figure 6 is a view of the wrenching tong and back-up tong of Figure 1 supported by a C-frame and fixed in a frame for handling equipment on tracks at a rig floor;

[0038] Figure 7 is a view of the wrenching tong and back-up tong of Figure 1 in use, with a tubular clamped in the wrenching tong;

[0039] Figure 8 is a view of an arrangement of an alternative wrenching tong and back-up tong;

[0040] Figure 9 is a view of an arrangement of a further alternative wrenching tong and back-up tong;

[0041] Figure 10 illustrates a modified tong arrangement;

[0042] Figure 11 illustrates a modified back-up tong;

[0043] Figure 12 illustrates in detail a clamping arrangement of the tong of Figure 11 including support elements;

[0044] Figure 13 illustrates an arrangement for connecting a drill bit to a length of drill pipe;

[0045] Figure 14 illustrates the arrangement of Figure 13 during the connection operation; and

[0046] Figure 15 illustrates the arrangement of Figure 13 following completion of the connection operation.

[0047] Figure 16 is a schematic view of a positioning apparatus according to aspects of the present invention.

[0048] Figure 17 is a schematic view of the positioning apparatus of Figure 16 in an actuated position.

[0049] Figure 18 illustrates the positioning apparatus of Figure 16 mounted on the tong of the present invention.

[0050] Figure 19 is a schematic view of the positioning apparatus of Figure 16 mounted on the tong of the present invention.

[0051] Figure 20 is a schematic view of the positioning apparatus of Figure 19 in an actuated position.

[0052] Figure 21 is a schematic view of a torque measuring flange attached to a motor housing.

[0053] Figure 22 is a schematic view of the torque measuring flange of Figure 21.

[0054] Figure 23 is a schematic view of the torque measuring flange of Figure 21 without the top plate.

[0055] Figure 24 is a schematic view of the torque measuring flange of Figure 23 in an actuated position.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0056] Figures 1 and 2 show an arrangement of a composite wrenching tong and back-up tong. A wrenching tong 1 is generally in the form of a disc with an opening 2 through the center thereof for receiving a stand of drill pipe (not shown), and a recess 3 cut from the edge to the opening 2 at the center. The wrenching tong 1 is provided with two pinion drives 4 arranged opposite each other at the periphery of the disc, equally spaced either side of the recess 3. Each pinion drive comprises a drive motor 5, drive shaft 6, and pinion 7 attached to the drive shaft 6.

[0057] A back-up tong 11 is located beneath the wrenching tong 1. The back-up tong is generally in the form of a disc with similar dimensions to the wrenching tong 1. The back-up tong is also provided with an opening 12 through the center and a recess 13 from the edge to the opening at the center. The opening 12 and recess 13 correspond to the opening 2 and recess 3 of the wrenching tong when the back-up tong 11 and the wrenching tong 1 are correctly aligned.

[0058] A plurality of guide rollers 10 or other guide elements are spaced around the edge of the wrenching tong 1 in order to maintain the alignment of the wrenching tong 1 with the back-up tong 11.

[0059] A gear 14 is provided around the periphery of the back-up tong 11, broken by the recess 13. The gear 14 meshes with the pinions 7 attached to the motors 5 on the wrenching tong, so that when the drive motors 5 drive the drive shafts 6 and gears 7, the wrenching tong 1 rotates relative to the back-up tong 11. The angle of rotation is limited by the recess 13 of the back up tong.

[0060] Figure 3 shows a back-up tong 11 before the wrenching tong is placed on top of it. The back-up tong 11 has a plurality of roller bearings 21, upon which the wrenching tong 1 is designed to be placed. The roller bearings 21 are supported by resilient means such as springs, elastic material or hydraulic/pneumatic cylinders, in order to support the wrenching tong during wrenching. During one wrenching cycle, the stands will move axially relative to one another as the connection is tightened. The wrenching tong must follow the axial movement of the top stand during one wrenching cycle. This axial travel length depends on the pitch of the thread.

[0061] Three clamping jaws 8 equipped with dies 9 are located inside each of the wrenching tong 1 and back-up tong 11: These are hydraulically driven for clamping the drill pipe stand in place in the center of the wrenching tong. The hydraulic power supply may be provided by hoses (not shown).

[0062] Figure 4 shows the clamping mechanism of the back-up tong 11. Three hydraulic pistons 16, comprising piston rods 17 and chambers 18, are located inside the casing of the back-up tong 11. Each piston rod 17 has an end 19 which is secured to the outside edge of the back-up tong 11. At the other end of the piston, the jaw 8 containing two dies 9 with teeth (not shown) is fixed to the chamber 18 by a spherical bearing 20. With the arrangement shown, each drill pipe stand is clamped by three jaws and six dies at the joint. The spherical bearings 20 enable the jaws and dies to match the pipe surfaces closely, resulting in a low penetration depth of the teeth of the dies into the pipe surface, and thus prolonging the life of the drill pipe. The wrenching tong has a similar clamping jaw design, as shown in Figure 5.

[0063] Figure 6 shows the wrenching tong 1 and back-up tong 11 supported by a C-frame 22 for handling at the rig. The C-frame 22 is in turn fixed in a frame 23 for handling the equipment on tracks at the rig floor. A drill pipe spinner 24 is mounted on the C-frame above the tongs for rotating a drill pipe stand at high speed.

[0064] In order to make a connection between two stands of drill pipe, the recesses 3 and 13 in the wrenching 1 and back-up 11 tongs are aligned (the tongs may already be in this configuration following the removal of the tongs from a previous section of tubing). Two stands of drill pipe 25,26 are then introduced into the openings 2,12 in the wrenching and back-up tongs 1,11, respectively, through the recesses 3,13, and the lower stand 26 is clamped in position in the back-up tong 11. The upper stand 25 is introduced into the drill pipe spinner 24, and rotated at high speed in order to pre-tighten the threaded connection. The final high torque will be applied by the wrenching tong 1.

[0065] The upper stand 25 is now clamped in position in the opening 2 through the wrenching tong 1. The pinion drives 4 are then driven to torque the connection between the stands 25,26 until the connection is fully tightened or until one of the pinion drives 4 is at the edge of the recess 13, at which stage the wrenching tong 1 is at one end of its possible arc of travel relative to the back-up tong 11. The maximum wrenching angle which can be reached in one cycle in the embodiment shown is +/-75°. If necessary, the upper stand 25 can then be released from the wrenching tong 1, the tong returned to its original position, and the torquing process repeated.

[0066] To break a connection, the above operation is reversed.

[0067] An even larger wrenching angle can also be simply achieved with this arrangement, as shown in Figure 7. The stands of drill pipe 25,26 are introduced to the tongs 1,11 through the recesses 3,13 and pretightened using the drill pipe spinner 24 as described above. However, before the top stand 25 is clamped in place in the opening 2, the wrenching tong drive is reversed, and the wrenching tong 1 is driven to its end position relative to the back-up tong, as shown in Figure 7. The top stand 25 is now clamped with the tongs in this position, so that with the embodiment shown a wrenching angle of 150° is achievable.

[0068] Figure 8 shows a similar arrangement of a composite wrenching tong and back-up tong to that described above. However, in this case only one pinion drive 4 is used, which increases the possible wrenching angle to 300°.

[0069] Figure 9 shows another similar arrangement, with two pinion drives 4 being used as in Figures 1 to 7. This time the pinion drives 4 are not opposite each other, but spaced 120° each side of the recess 3. This gives the advantage of the torque and control provided by two drives, but allows a higher wrenching angle than the arrangement of Figure 1. The maximum wrenching angle in this embodiment will be in the region of 210°.

[0070] The torque can be monitored by measuring the reaction torque at each drive by means of a load cell, or by measuring the pressure of the drive motor.

[0071] It is to be understood that other variations are possible while still falling within the scope of the invention. For example, the preferred embodiments show an arrangement whereby the pinion drives are mounted on the wrenching tong and the gear is mounted on the back-up tong. However, the arrangement could be the other way round with the pinion drives mounted to the back-up tong and the large gear mounted on the wrenching tong. Such an arrangement is illustrated in Figure 10.

[0072] Alternatively, the wrenching tong could be provided with a gear, and the pinion drives mounted on the frame 24.

[0073] Hydraulic clamping cylinders are shown, but the tong could clamp the drill pipe stands by any known means.

[0074] The preferred embodiments show one or two pinion drives, but more could be used if arranged in a suitable configuration.

[0075] Although the preferred embodiments have been described in relation to tightening stands of drill pipe, it is to be understood that the arrangements described are suitable for applying torque to any tubular sections.

[0076] Figure 11 illustrates in partial section a modified back-up tong 40 which may replace the back-up tong 11 of the embodiment of Figure 1 to 9. The modified tong 40 has only two jaws 41 associated with respective clamping arrangements 42. Each arrangement 42 is held in place within the main body 43 of the tong 40 by a set of four "pendulum" bolts 44. A clamping arrangement 42 associated with four pendulum bolts 44 is illustrated in more detail in Figure 12 from which it can be seen

that each bolt comprises a cylinder cut in half along its longitudinal axis to provide a flat surface and a rounded surface. The flat surface of each bolt 44 abuts the side of the clamping arrangement 42, whilst the rounded side is located in a rounded recess 45 provided in the side of the main body 43 opposed to the clamping arrangement. It will be appreciated that as the bolts 44 are able to rotate within their respective recesses in the tong body 43, each clamping arrangement 42 may pivot slightly about its center. This allows the jaws 41 to conform to the outer surface of a tubular to be clamped when the tubular is for example not perfectly cylindrical.

[0077] Figure 13 illustrates apparatus which can be used in association with a tong arrangement 49 to connect and disconnect a tool such as a drill bit to and from a length of tubular such as a drill pipe. The apparatus comprises a basket 50 which is arranged in use to be placed on the floor of a drilling rig. The basket 50 has an opening in the top thereof for receiving a tool 51 which is to be connected to a length of tubular 52. The opening has a shape which is complimentary to the shape of the tool 51 such that the tool is held securely in an upright position and rotation of the tool within the basket 50 is prevented.

[0078] Two opposed sides of an upper plate of the basket 50 are provided with slots 53. These slots 53 are shaped to receive locking members 54 which project downwardly from the lower surface of the back-up tong 55 of the tong arrangement. The operation to connect a tool will now be described.

[0079] As shown in Figure 13, the tool 51 is first located in the basket 50. The length of tubular 52 is moved to a position over the tool (Figure 14) and is lowered to bring the box of the tubular into engagement with the externally threaded coupling of the tool 51. At this point, the tong arrangement is brought up to the tubular 52 with the jaws of the rotary and back-up tongs being fully opened, and the tong is placed around the tubular 52. The tong arrangement is then lowered within its frame, to a position in which the locking members 54 are received by the respective receiving slots 53 of the basket 50. In this position, the basket is locked to the back-up tong. The jaws of the rotary tong are then clamped against the tubular 52 and the rotary tong rotated, relative to the back-up tong, to tighten the threaded joint (Figure 15). The jaws of the rotary tong are then released, and the tong arrangement withdrawn

from around the tubular. The tubular and the connected too1 can then be lifted clear of the basket 50.

[0080] It will be appreciated that the tool 51 may be disconnected from the tubular 52 by carrying out the same operation but in reverse.

[0081] Figure 16 illustrates a positioning apparatus 100 which may be used in association with the tong 1 of the present invention. Typically, the positioning apparatus 100 is mounted onto a lower portion of the tong 1 as shown in Figures 18 and 19. The tong 1, in turn, is disposed on a movable frame 23. In one aspect, the positioning apparatus 100 may be used to position the drill pipe 105 in the center of the tong 1. Placing the drill pipe 105 in the center position reduces the possibility that the jaws 8 of the tong 1 will damage the drill pipe 105 when the tong 1 is actuated.

[0082] The positioning apparatus 100 includes a plunger 110 slidably disposed on a base 120 as illustrated in Figure 16. The base 120 may include one or more guides (not shown) defining a track for the plunger 110 to traverse. The plunger 110 is positioned such that it may contact the drill pipe 105 as it enters an opening 12 in the tong 1. A contact member 115 is disposed at a contact end of the plunger 110. A contact support 118 may be used to alleviate the contact force endured by the contact member 115.

[0083] One or more biasing members 130 are used to couple the plunger 110 to the base 120. The biasing members 130 are used to maintain the plunger 110 in an initial position as seen in Figure 16. Preferably, two springs 130 are used to couple the plunger 110 to the base 120. Specifically, one end of the spring 130 is attached to the base 120 and the other end of the spring 130 is attached to the plunger 110. The springs 130 may be attached to the plunger 110 by latching onto a rod 135 extending across the plunger 110.

[0084] The positioning apparatus 100 further includes a visual locator 140. In one embodiment, the visual locator 140 may include a housing 150 having two elongated slots 161, 162. Preferably, the elongated slots 161, 162 are substantially parallel to each other. A first indicator 171 and a second indicator 172 are movably coupled to a first elongated slot 161 and a second elongated slot 162, respectively. The first indicator 171 may be coupled to the plunger 110 using a cable 180,

whereby one end 180A of the cable 180 is attached to the plunger 110 and the other end 180B attached to the first indicator 171. The cable 180 is movable within a sleeve 190 having one end 190A attached to the base 120 and the other end 190B attached to the visual indicator 140. In this manner, movement in the plunger 110 may cause the first indicator 171 to travel the same distance along the first elongated slot 161.

[0085] The second indicator 172 may be set at a predetermined position on the second elongated slot 162. The predetermined position correlates to the desired position of the drill pipe 105 relative to the tong 1. Generally, the tong 1 will grip the pipe joint 108 instead of the drill pipe 105 during the connection process. Therefore, the diameter of the pipe joint 108 will generally be used to determine the proper location of the drill pipe 105. Because the second indicator 172 is movable, the positioning apparatus 100 is useable with the tong 1 to position drill pipes 105 of various size.

[0086] In operation, the positioning apparatus 100 is mounted onto the tong 1 with the plunger 110 protruding towards the opening 12 in the tong 1 as illustrated in Figures 18 and 19. As shown, the plunger 110 is in the initial position and the springs 130 are unactuated.

[0087] As the frame 23 moves the tong 1 towards the drill pipe 105, the plunger 110 contacts the drill pipe 105 before the drill pipe 105 reaches the center of the jaws 8. Thereafter, the plunger 110 is pushed away from the tong 1 as the tong 1 continues to move closer to the drill pipe 105 as illustrated in Figures 17 and 20. Specifically, the plunger 110 slides along the base 120 as the tong 1 moves closer, thereby extending the springs 130. At the same time, the end 180A of the cable 180 attached to the plunger 110 is pushed into the sleeve 190, thereby causing the end 180B of the cable 180 attached to the first indicator 171 to extend further from the sleeve 190. In this manner, the first indicator 171 is moved along the first elongated slot 161.

[0088] The drill pipe 105 is properly positioned when the first indicator 171 reaches the level of the second indicator 172 as seen in Figures 17 and 20. Thereafter, an operator observing the visual indicator 140 may stop the tong 1 from moving further. After the connection process is completed, the frame 23 is moved

away from the drill pipe 105. The biasing members 130 bring the plunger 110 back to the initial position, thereby causing the first indicator 171 to move away from the second indicator 172.

[0089] According to another aspect, the movement of the tong 1 may be automated. In one embodiment, the visual locator 140 may further include a first sensor (not shown) to indicate that the first indicator 171 is proximate the second indicator 172. The first sensor is triggered when the first indicator 171 is next to the second indicator 172. This, in turn, sends a signal to a programmable controller (not shown) to stop the advancement of the tong 1. In another embodiment, a second sensor (not shown) may be used to indicate that the first indicator 171 has moved past the second indicator 172. If the first indicator 171 moves past the second indicator 172, the second sensor may send a signal to the programmable controller to prevent the tong 1 from actuating and back-up the tong 1 until the proper position is attained.

[0090] Figure 18 illustrates a torque measuring flange 200 which may be used in association with the tong 1 of the present invention. In one aspect, the flange 200 may be used to measure the torque applied to makeup or breakup the drill pipe 105. Drill pipe connections are generally designed to makeup or breakup at a specific torque. If insufficient torque is applied, the connection may not conform to the requisite specifications for use downhole. On the other hand, if too much torque is applied, the connection may be damaged. As discussed above, the torque applied to the tong 1 can be monitored by measuring the pressure of the drive motor 5. Thus, a torque measuring flange 200 is useful in monitoring and controlling the torque applied to the drill pipe connection.

[0091] According to aspects of the present invention, the flange 200 may include a top plate 210 and a bottom plate 215 as illustrated in Figure 21. The top plate 210 may be connected to the motor housing 205 and the bottom plate 215 may be connected to the gear housing (not shown). A splash guard 202 may be used to enclose the flange 200. Referring to Figure 22, the bottom plate 215 has a tubular portion 218 disposed in the center for housing the shaft 6 which couples the motor 5 to the gear 7. The tubular portion 218 also prevents debris or grease from the shaft 6 from entering the interior of the flange 200. The plates 210, 215 may be

connected to each other using one or more bolts (not shown). Preferably, elongated slots 219 are formed on the bottom plate 215 for connection with the bolts. As will be discussed below, the elongated slots 219 allow the plates 210, 215 to rotate relative to each other during operation.

[0092] One or more wedges 230, 235 may be disposed inside the flange 200. Preferably, two wedges 230 are attached to the top plate 210 and two wedges 235 are attached to the bottom plate 215. The wedges 230, 235 on each plate 210, 215 are disposed at opposite sides of the plate 210, 215, whereby the base of the wedge 230, 235 is substantially parallel to one side of the plate 210, 215. The plates 210, 215 are brought together in a way that the four wedges 230, 235 are equally spaced apart in the flange 200.

[0093] The flange 200 may further include one or more torque measuring cylinders 250. As shown in Figure 8, each cylinder 250 is placed between two wedges 230, 235. Preferably, the cylinders 250 are freely movable within the flange 200. In one embodiment, the cylinders 250 are fluid containing chambers having a piston 260 at least partially disposed within the chamber. The piston 260 may further include an axial spherical bearing 265 disposed at an outer end of the piston 260 for auto-alignment with the wedges 230, 235. When the piston 260 contacts a wedge 230, 235, the bearing 265 may pivot against the contact surface thereby achieving maximum contact with the wedge 230, 235. Bearings 265 may also be placed on the end of the cylinder 250 opposite the piston 260.

[0094] As indicated earlier, the cylinders 250 are capable of indicating the torque applied by the motor 5. In one embodiment, each cylinder 250 may include a pressure transducer (not shown) for determining the torque applied. The pressure transducer may convert the fluid pressure in the fluid chamber into electrical signals that can be sent to a programmable logic controller (not shown) as is known to a person of ordinary skill in the art. The controller may be programmed to operate the tong 1 based on the signals received. Alternatively, a pressure line may be use to connect the cylinder 250 to a pressure operated gauge. The gauge can be calibrated to read the pressure in the cylinder 250. In this manner, any pressure change in the cylinder 250 can be monitored by the gauge.

[0095] In operation, the flange 200 is disposed between the motor housing 205 and the gear housing. Specifically, top plate 210 is attached to the motor housing 205 and the bottom plate 215 attached to the gear housing. When the motor is actuated, the motor housing 205 experiences a torque 280 in the opposite direction of the torque 285 applied by the motor 5 as illustrated in Figure 21. The housing torque 280 is translated from the motor housing 205 to the top plate 210. As discussed above, the top plate 210 is bolted to the bottom plate 215 through the elongated slot 219 in the bottom plate 215. The elongated slot 219 allows the top plate 210 to move relative to the bottom plate 215 when torque is applied. The relative rotation causes the wedges 230, 235 to compress against the cylinders 250. This, in turn, compresses the piston 260, thereby increasing the fluid pressure in the cylinder chamber.

[0096] Figure 23 illustrates a top view of the flange 200 with the top plate 210 removed. The flange 200 is shown before any torque is translated to the top plate 210. Figure 24 illustrates a top view of the flange 200 after the torque is translated to the top plate 210. It can be seen the wedges 230 attached to the top plate 210 have been slightly rotated in relation to the wedges 235 on the bottom plate 215. This rotation compresses cylinders 250B and 250D between the wedges 230, 235, thereby compressing the piston 260 in the cylinders 250B, 250D. However, pistons 260 of cylinders 250A, 250C are not compressed because the wedges 230 have been rotated away from the cylinders 250A, 250C. Instead, the pistons 260 are allowed to extend from the cylinders 250A, 250C. It is appreciated that the aspects of the present invention are equally applicable when the motor 5 rotates in the opposite direction.

[0097] If a pressure transducer is used, the pressure in the cylinder 250 can be converted to an electric signal that is sent to a programmable controller. In this manner, the torque applied by the motor 5 can be controlled and monitored by the controller. Alternatively, if a pressure gauge is used, the change in pressure may be observed by an operator. The operator can then operate the tong 1 according to the pressure readings.

[0098] While the foregoing is directed to embodiments of the present invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.